No page 1 and page 2 from the original document

Translation starts from page 3

The best flow direction can be achieved. Since the evaporation and mixing can be arranged arbitrarily, it can be replaced by another axial shift gear which can prevent mixing zone from directive radiation from flame.

The other relative and beneficial natures of this inventive plot have been explained in its other deriving rights.

The detailed explanations are given next following the implement figures. The less important parts are omitted in the explanation without confusion of understanding the invention. The arrow denotes the medium flowing direction. Same part is marked by same symbol in different figures.

The figures are:

Figure 1	Pre-mixed circular combustor,
Figure 2	Perspective drawing of vortex generator,
Figure 3	Alterable plot of vortex generator,
Figure 4	Associating alterable plot of vortex generator in figure 3,
Figure 5	Vortex generator in pre-mixed channel and
Figure 6-12	Fuel transport plans coupled with vortex generator.

The rotating symmetric pre-mixed combustor 1 is shown at the center line 14. The pre-mixed combustor 1 can be constructed by single pipe or multi-pipes surrounding the center line 14 in circle. In addition, there is an entering channel 8 expanding along axial and azimuthal direction at region 9 ahead of the combustor 1. The cooling air 7 flows in from channel 8 and it cools off the region 9 continuously and then flows through around the outside case of the combustor 1. It is better to introduce the cooled air at the relevant

positions into the pre-mixed combustor 1. It is so called convective heat cooling process. The penetrating cooling, or film cooling precisely, can be achieved by drilling holes along the guiding pipe on the combustor 1. There is a rotator 200 (referred as a vortex generator hereafter) ahead of pre-mixed combustor 1. This vortex generator forces incoming air 2 used in combustion rotating. The detailed information on the vortex generator has been given in figure 2-12. The incoming air 2 can be fresh air or re-circulating mixture. The selective fuel can be mixed into either the fresh air or mixture. In addition, the incoming air can be pre-heated based on the working circumstance. The fixed fuel is injected into the pre-mixed combustor 1 through the downstream side of vortex generator 200. There should be at least one fuel nozzle in the flow channel on the combustor 1 when it uses liquid fuel 12 a. The fuel nozzle should be atomizing one. At least one more rotator 4 should be located at the upstream of the fuel nozzle 12 so that injected fuel can pass through along axial and/or radial direction or with certain angle. The liquid fuel 12a injected by fuel nozzle 12 is forced to rotate continuously by the incoming air used in combustion due to the arrangement of rotator 4. This in turn generates liquid fuel spray droplets with diameter less than 20 μm (micron). The rotator 4 which also can be located inside the channel wall can be arranged like blades around the circumference, or according to requirements of EP—321809 combustor. The rotator 4 can be manufactured based on technique conditions of vortex generator 200. The vortex generator 200 located at the pre-mixed combustor can be omitted for some specific situations. It should be pointed out that the flow characteristic of incoming air can be improved due to the vortex generator presented. The vortex generator 200 is arranged at different location of cross section at entrance region 3. The length of evaporation zone 6 for the atomization purpose should be long enough so that the liquid fuel coming out from the action of fuel nozzle 12 and rotator 4 reaches fully vaporization before arriving at inlet of combustor 9. It is better to keep the channel cross section from rotator 4 to inlet of combustor 9 unchanged. The separation zone should be at the region 10 of combustor 16 after flow passing through the smooth diverged and zigzag diverged channel. The resultant recirculation zone 11 can keep the pre-mixed combustor 1 at normal working condition even for extreme fuel lean cases. In order to achieve the best fuel/air ratio for gas fuel 5a, it should be arranged some nozzles around the azimuthal direction in

combustor 1 and along the rotator 4. Each rotator 4 should equipped with such nozzle. In low load case, it may be equipped with supplementary fuel nozzle 15 for using liquid and or gas fuel 12a and 5a. In general, the pre-mixed combustor 1 can work at mutual ways without any problem. At the upstream where the main fuel 12a, 5a are injected, there is a convex region 13 in the guiding section of combustor 1. This convex region can prevent the fuel atomization from the flame radiation and ignition. The necessary vaporization of liquid fuel can be guaranteed since the fuel nozzle 12 works with extremely high flow rate.

The entrance 3 is not shown in figure 2, 3 and 4. Instead, the air direction is shown by arrow. Based on the figures, the vortex generators 200, 201 and 202 are constructed by three triangles allowing free circulations. Each triangle has a top face 210 and two side faces 211 and 213. These faces expand along the flow direction with specific angles respectively. The side faces of vortex generator 200, 201 and 202 should constructed by right triangles. The longer leg of the right triangle should be fixed at the channel wall 17 and should be watertight. The angle between two side faces is α degree. The connection edge 216 is perpendicular to the channel wall 17. The shape and orientation of side faces 211, 213 in figure 4 are symmetric. Faces 211 and 213 are located at the both sides of asymmetric line 217. The asymmetric line follows the channel axial orientation.

Same as faces 211 and 213, the narrow edge 215 is fixed at the channel wall 17. The longitudinal edges 212 and 214 are parallel to the side faces 211 and 213 which are extended into the channel. The top face 210 has an angle θ with the channel wall and its longitudinal edges 212, 214 form a sharp point 218 with the edge 216. The vortex generators 200, 201 and 202 also may have bottom sides. They could be fixed at the channel wall 17 with similar manner. These bottom sides are irrelevant with the device functions.

The functions of vortex generators 200, 201 and 202 are described as following. The main flow 2, while flowing around edges 212 and 214 shown in relevant figure, is separated to several pairs of vortex which swirls in opposite directions The axis of the

vortex is along the main flow direction. The vortex separation points can be adjusted by choosing angle θ and α (note, recirculation zone = vortex separation). When increasing angle, the vortex strength or angular velocity will increase and the separation points will move to upstream against flow direction. Thus these two angles, θ and α, should be preset based on the application and structure condition. It also should adjust the length and height of vortex generator as well following figure 5.

In figure 2, the connection edge 216 of side face 211 and 213 is the downstream edge of vortex generator 200. The edge 215, called block edge, is the first place to change flow's direction.

Figure 3 shows a so called "half vortex generator" based on the full one in figure 2. The half vortex generator 201 only has a half angle $\alpha/2$, and another side faces flow direction. The vortex is only generated at the side shown by arrow which is different from the symmetric case. Thus there is no vortex free zone downstream where only the flow medium is forced to rotate.

The configuration in figure 4 is arranged by rotating that in figure 2 with 180 degrees. and thus the connection edge 216 becomes the first block edge to flow. Therefore the vortex's swirling direction has been changed.

Figure 5 shows the basic geometry of vortex generator 200 installed in the channel 3. The height h of connection edge 216 and height H of channel should be adjusted so that the induced vortex occupies entire channel. This arrangement will result uniform velocity distribution at the loading cross section. Another factor to choose the ratio h/H is pressure loss when flow passing over vortex generator 200. It is obvious that the higher ratio h/H will result more pressure loss.

The vortex generators 200, 201 and 202 are mainly used at the mixing zone of two different media. When the main flow 2, gas and/or liquid fuel, collides with the connection edge 215 or 216, a secondary flow will be formed. The flow rate of this

secondary flow is much smaller than that of main flow and it mixed with certain amount of air at any time shown in figure 1. This small flow is mixed with the main flow at downstream.

The vortex generators 200 are distributed with some distances in between inside and outside of the channel 3 and they are also can be distributed along the azimuthal direction in parallel. The purpose is that the distribution does not leave void space in channel 17, and the last, the number of vortex generator is the key to generate demanded vortexes.

Figures 6 -12 show other injections to add fuel into main flow 2 - air used in combustion. These alterable plans can be combined with different fuel injection plans.

Figure 6 shows that the fuel can be injected into the combustor from two different positions, one from hole 220 on channel wall and another from hole 221 between side faces 211 and 213 where the vortex generator presented. The fuel injected by the latter injection point will increase an additional kinetic energy to vortex and thus can extend the life time of vortex generator.

Figure 7 and 8 show that the fuel is injected through either a narrow path 222 or hole 223, respectively. The narrow path or hole should be located in front of the edge 215 and should be parallel to channel wall 17 where there is a vortex generator. The geometric configuration of narrow path 222 or hole 223 should be determined as such that the main flow 2, mixed with the injected fuel at a certain angle, should generate a protection layer which can protect the vortex generator.

In the next descriptions, the secondary flow (see description above) is first introduced inside of vortex generator through guiding hole on the channel 17, therefore it can cool off the vortex generator partially.

Figure 9 shows that the fuel is injected through hole 224 which is located on the top surface 210 closing and paralleling the edge 215. The cooling effect to vortex generator is

mainly from outside, not from inside. The secondary flow around the top surface 210 can form a protection layer.

Figure 10 shows that the fuel is injected through hole 225 which is located on the top surface 210 in parallel along symmetric line 217. This arrangement can prevent channel 17 from heat impact of main flow 2 effectively since the fuel will be added to outer circumference of swirling flow.

Figure 11 shows that the fuel is injected through hole 226 which is located on the top surface 210 along edges 212 and 214. This arrangement can cool off the vortex generator effectively. This is because the fuel is injected at the end and has enough time to flow around entire inner channel. The secondary flow is directly added to the swirling flow and form a mixture at a certain ratio.

Figure 12 shiws that the fuel is injected through hole 227 which is located at the side faces 211 and 213 between edges 212, 214 and 216. The function of this arrangement is similar to that in figure 6 (hole 221) or figure 11 (hole 226).

Nomenclature

1	Pre-mixer
2	Main flow
3	Inlet
4	Rotator
5	Nozzle
5a	Gas fuel
6	Vaporization zone
7	Cooling air
8	Cooling air channel
9	Combustor front
10	Cross section of combustion chamber

11	Recirculation zone
12	Fuel nozzle
12a	Liquid fuel
13	Convex
14	Axial center line
15	Fuel nozzle
16	Combustion chamber
17	Channel wall

200, 201, 202	Vortex generators
210	Top surface
211,213	Side faces
212, 214	Longitudinal edges
215	Transverse edge
216	Connection edge
217	Symmetric line
218	Tip point
220-227	Fuel injection holes
L, h	Size of vortex generator
H	Chamber height
α	Direction angle
θ	Orientation angle

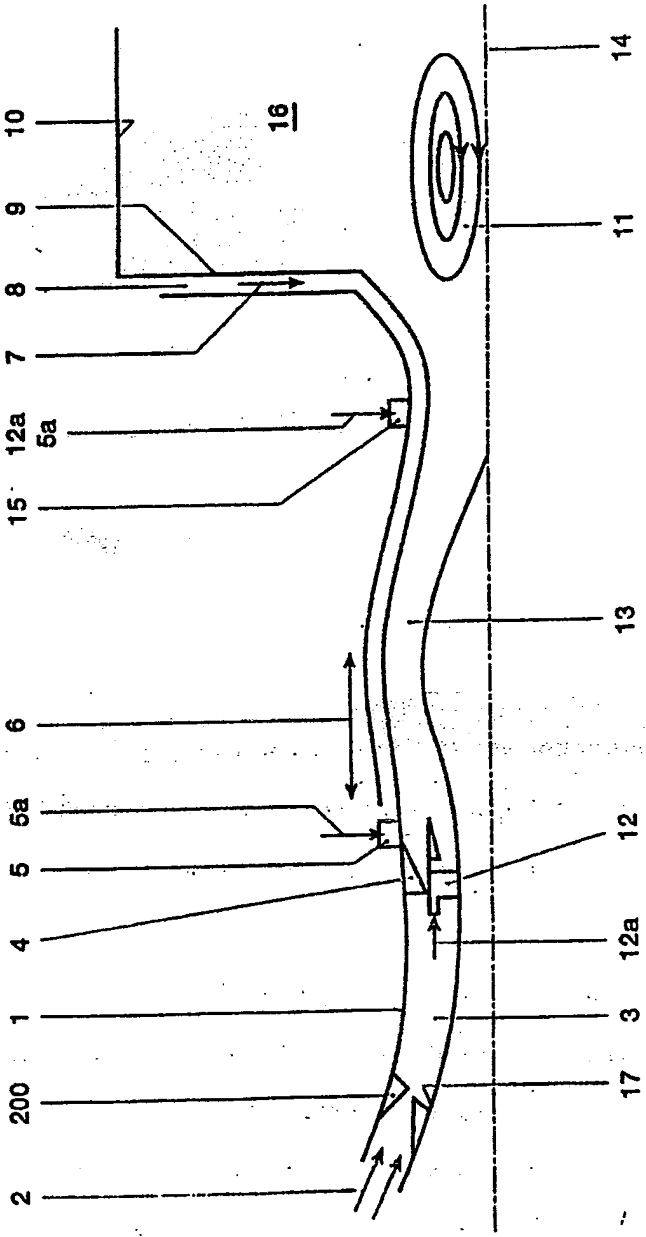

图 1

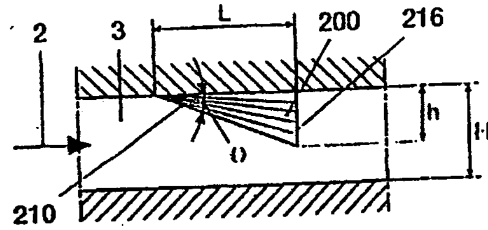
2
3
L
200
216
h
H
θ
210

图 5

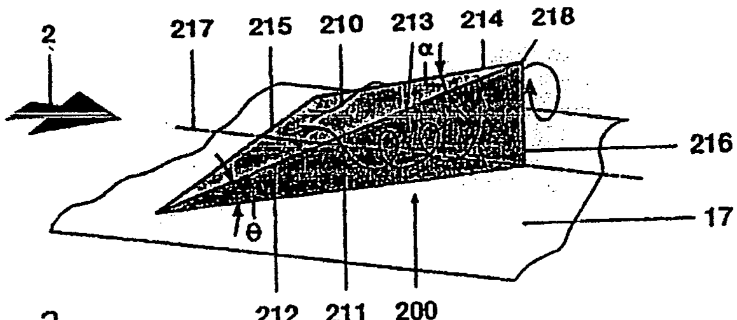
2
217
215
210
213
214
218
α
216
θ
17
212
211
200

图 2

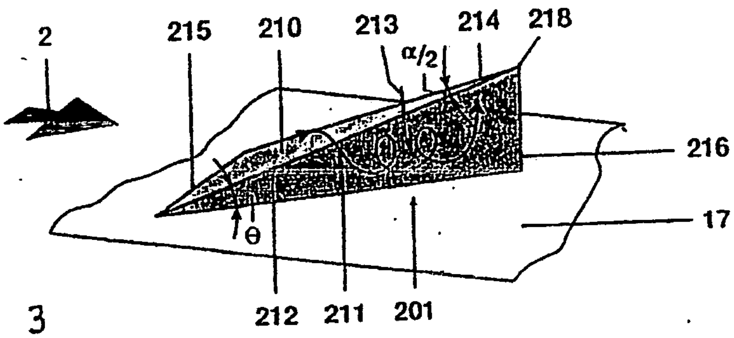
2
215
210
213
214
218
α/2
216
θ
17
212
211
201

图 3

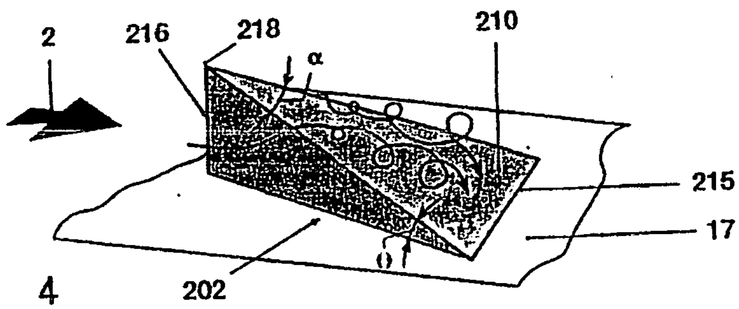
2
216
218
210
α
215
17
θ
202

图 4

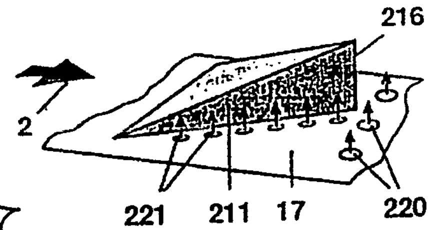

图 6

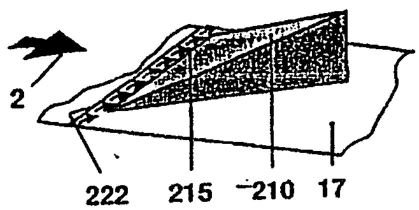

图 7

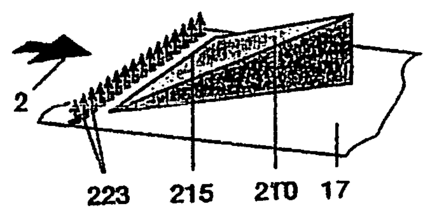

图 8

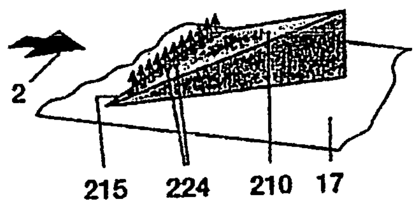

图 9

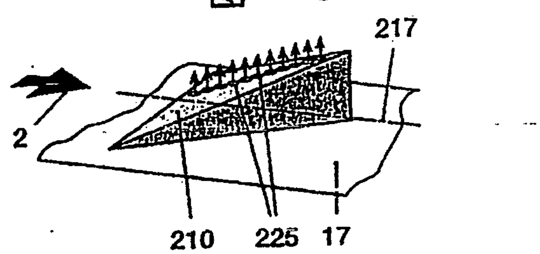

图 10

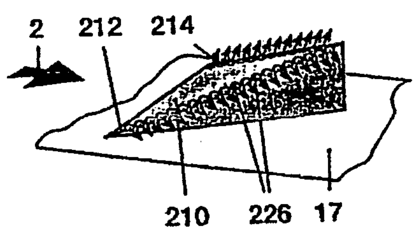

图 11

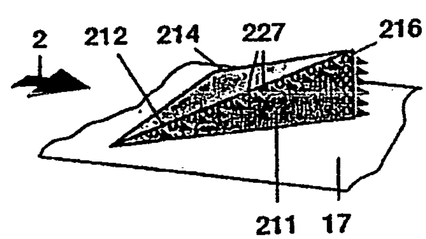

图 12